Habitat Expansion Agreement

for

Central Valley Spring-Run Chinook Salmon and California Central Valley Steelhead

Questionnaire Instructions

The attached questionnaire is intended to solicit information needed by the Steering Committee to review projects relative to the criteria established in the Habitat Expansion Agreement. For each proposed action (project), please complete the questionnaire to the fullest extent possible. Please provide citations where applicable and provide a full reference for each citation at the end of this questionnaire (Section X. Supporting Documents). Specific instructions follow.

I. Contact Information

Provide the name of the agency or group making the proposal as well as a contact person for the project. Include contact information such as mailing address, phone number, and email address.

II. Project Description

Provide a descriptive name for the action (project). If the action is listed in the *Working List of Potential Habitat Expansion Actions* (provided during the January 2009 meetings of HEA parties), please include the reference number associated with the action. The project location should specify the watershed or subwatershed (e.g., Deer Creek, Beegum Creek) as well as specific areas within the watershed where the project will be located and what portions of the watershed will benefit from the project. Please include geographic coordinates of the project location(s), if applicable. The project description should be a narrative that provides as much detail as possible about the project.

III. Species Limiting Factors

In this section, indicate the factors that currently limit production of spring-run Chinook salmon and/or steelhead in your watershed. The intent is that the environmental and biological objectives of your project address these limiting factors in some way. Please check one or more of the limiting factors that apply to your watershed. In the second column, describe how and where the factor limits spring-run Chinook salmon and/or steelhead. For each factor that you check, please rank its effect on spring-run Chinook salmon and/or steelhead using the drop-down box in the last column. Finally, we also ask that you describe the source of your conclusions, such as a watershed assessment or other document. Please provide enough information that we can find the document if we need it.

IV. Project Objectives—Environmental

Environmental objectives describe how the project is intended to address the limiting factors to achieve the biological objective described in the next section. Environmental objectives should be as specific and quantitative as possible (e.g., reduce gravel embeddedness in the watershed from 75% to 25% by fencing riparian areas to exclude cattle and allow riparian forest to reestablish). Describe how you think environmental objectives relate specifically to the biological objectives. In the last column, we ask you to describe the environmental objectives as either the primary or secondary focus of the project. For example, a project to plant trees might have a primary focus on riparian/floodplain function with a secondary focus on temperature or water quality.

V. Project Objectives—Biological

Biological objectives describe the anticipated biological response from the project and should be as quantitative as possible. Indicate which species and life stages are the focus of the project. Describe specifically the general condition of the target species in your watershed relative to the historical abundance. The condition of the species should be indicated using the categories in the drop-down box. Species condition categories are defined on the last page of this form. Biological objectives should include the following information: (1) an estimate of the expected contribution of the project in terms of potential adult returns, to the extent possible (and an explanation of how the estimate was developed); and (2) an explanation of how the biological objective for the species is addressed by the action relative to the environmental limiting factors (e.g., the biological objective of an action might be to increase egg incubation survival in a watershed that is currently limited by sediment levels).

VI. Project Cost

To the extent possible, estimate the capital cost of the project, the annual operating and maintenance (O&M) cost, a description of annual O&M activities, and the project lifetime (i.e., how many years O&M activities are expected, including indefinitely, and how long until you expect the project to provide benefits). Provide any confirmed or potential funding partners, or opportunities for cost sharing with other funders or between projects. Also, identify any confirmed or potential partners that might provide maintenance support for the project (funding support or labor support).

VII. Schedule

Describe the project schedule, including a potential start date, construction period, and environmental and biological response times (i.e., the expected time to realize environmental and biological benefits). The last points refer to the maturation period for the project during which time environmental conditions develop. For example, it may take 50–100 years before full environmental benefits (e.g., shading, channel stability, water quality) of planting riparian trees are realized.

VIII. Feasibility

Describe the feasibility and challenges of the project. Feasibility issues should include primarily technical issues, success of projects utilizing similar technology, and particular challenges posed by the specific project. Other issues of feasibility that may be included are challenges associated with property ownership, permitting, zoning, and other social-economic-legal issues.

IX. Project Support

Describe the support or potential conflicts associated with the project. Specifically, provide supporting and cooperating entities (e.g., agencies, non-governmental organizations). Are there cooperating agencies or groups, aside from the potential funding partners mentioned previously? Describe the degree of local support and any known opposition or conflicts with other parties.

X. Supporting Documents

Provide full references for each citation used to support the information presented in this questionnaire for your project. At a minimum, a reference should include the author(s) name; name of agency/organization (if applicable); title of the document; volume and title of journal, if the document is taken from a professional journal; and publisher, date, and location of publication.

Questionnaire

for

Information on Potential Projects to Support Spring-Run Chinook Salmon and Steelhead in the Sacramento River Basin for the Habitat Expansion Agreement

DUE: Thursday, April 30, 2009

Send completed questionnaires to hea@water.ca.gov

I. Contact Information

Name:	Joanne Hild
Organization:	Friends of Deer Creek
Address:	132 Main Street
City, State, Zip Code:	Nevada City, CA 95959
Phone Number:	530-265-6090
Email Address:	joanne@friendsofdeercreek.org

II. Project Description

Project Name:	Deer Creek Salmon and Steelhead Spawning Habitat Expansion Project
Reference No. or New:	
Project Location:	Deer Creek between Lake Wildwood and the confluence with the Yuba River. 39.2358 deg N; 121.2190 deg W at the Lake Wildwood dam.

Project Description:

The Deer Creek Salmon and Steelhead Habitat Expansion Project is an effort to restore critical habitat for Spring-run Chinook salmon and steelhead through a combination of targeted gravel augmentation, barrier removal, invasive species removal, riparian revegetation, and collaboration with affected stakeholders, especially Lake Wildwood. In August 2008 the California Department of Fish and Game included Deer Creek on its list of 22 priority streams for future instream work. The list was compiled and ranked based on input from Regional DFG staff, staff from the State Water Board, U.S. Fish and Wildlife Service, and the National Marine Fisheries Service, using the following criteria: 1) Presence of anadromous species; 2) likelihood that DFG flow recommendations would provide a high level of improvement; 3) availability of recent flow studies or other relevant data; and 4) the possibility of

II. Project Description

partners/willing landowners. This proposal is offered in conjunction with the Yuba River Narrows Spawning Habitat Rehabilitation Project proposed by South Yuba River Citizens League.

The mouth of Deer Creek was once an exceptionally rich salmon and steelhead habitat for the Yuba River. Salmon and steelhead were present on Deer Creek and Squirrel Creek, a tributary of Deer Creek, in large numbers in the early part of the 20th century. Steelhead were observed in the 1960's in the first quarter mile of Deer Creek, until the impassible falls, and salmon were observed in large numbers in the 1920's (Yoshiyama, Gerstung, Fisher, and Moyle).

Lake Wildwood reservoir dam on Deer Creek, constructed in 1970, blocks the downstream movement of gravel that is essential for fish spawning habitat, and causes severe impacts to all elements of Deer Creek's riverine function, especially temperature, flow, and nutrient loads. Friends of Deer Creek has worked for the past several years with the Lake Wildwood Lake Committee to make changes to their recreational management of the reservoir that take into account the impacts to the creek. Much work remains if Deer Creek's salmon and steelhead spawning habitat is to be restored and expanded. This proposal is an effort to mitigate the impacts to the creek and make permanent changes in the management of the system that prevent the impacts from recurring.

Assessment, planning and design can begin immediately, with implementation beginning in September 2009. All necessary permits for the implementation of this project have been submitted.

The project elements are as follows:

1. Gravel Augmentation: Lake Wildwood dam is located four and a quarter miles above the confluence with the Yuba, where it has a detrimental impact on Deer Creek's remaining salmon and steelhead spawning habitat. The primary objective of this project is to work with Lake Wildwood to recover the gravel that is prevented by the dam from passing downstream, and to place it along with purchased gravel as needed in the gravel-starved lower reaches of Deer Creek that are critical spawning habitat. While mercury-laden fines are able to cross the dam during storm and dewatering events, larger gravel and pebbles are prevented from passing. Replacement of gravel below the dam will restore a critical ingredient of salmonid spawning habitat as well as a vital but poorly understood element in the overall function of the stream, with beneficial impacts to temperature, flow, oxygenation, and fish and other wildlife populations.

2. Revegetation: We propose a revegetation effort for the four and a quarter mile stretch of creek from the Lake Wildwood dam to the confluence. The effort will focus on the riparian zone, meadow/floodplain areas and upland zones. Like most of the watershed, this area is infested with invasive non-native species that outcompete beneficial native species and interact with the climatic conditions to create parched, tinder-dry conditions in the long hot summers. Of particular concern are Himalayan Blackberry (Rubus discolor), Black Locust trees (Robinia pseudoacacia) and non-native grasses in the riparian zone, Scotch Broom (Cytisus scoparius) and Yellow Star Thistle (Centaurea solstitialis) in the meadow areas, and Ripgut grass in the upland areas. Revegetation from the native palette would restore the capacity to uptake nutrients, thereby reducing the extent of algae blooms that have severely impacted lower Deer Creek. Algae blooms cause large diurnal swings in pH, creating conditions that are lethal to native aquatic organisms. These algae blooms and resulting pH increases have caused the State Board to include Deer Creek as an impaired watershed for pH on the 303(d) list. Revegetation will increase tree cover in the riparian zone, thereby reducing direct solar radiation available as energy for algae. Invasive Himalayan blackberry, prevalent throughout the riparian zone, provides little shade and blocks access to the creek for larger animal species. Blackberry also contributes to erosion as the stream flows around the rootball, undermining the soil. By contrast, native willows overhang the water, remain lush and green all summer long, hold the soil in their roots, and provide copious shade that keeps the water cool. Their roots provide habitat and protection from predators for a variety of animal species. Revegetation of denuded sections of the riparian zone will also help control sediment loads in the creek that result from erosion. This stretch of creek is dominated by a single highly pollution-tolerant macroinvertebrate family, indicating overall ecological degradation. Improved riparian habitat is likely to result in increased macroinvertebrate diversity in addition to providing numerous habitat and water quality benefits for the target species and other riverine and riparian dependent species.

3. Barrier Removal: The third project element is the assessment and removal of barriers to anadromous fish passage. Salmon and steelhead were once present for several miles along Deer Creek and its tributaries, but their range is now limited to the first quarter mile of stream. At this point, a large and impassible waterfall, known as Basher

II. Project Description

Falls, prevents their passage. Salmon were once able to ascend these falls because the presence of gravels in the creek maintained the height of the stream bed and prevented the creek from incising, and large woody debris acted as natural fish ladders to facilitate fish passage. Gravel loads upstream of the falls will restore stream elevation, and targeted gravel placement at the falls will focus on restoring passibility. Native trees, once established, will provide the necessary large woody debris. In addition, we will explore and implement other options for restoring passibility to the falls as indicated. We will also survey any additional barriers to fish passage that lie between the confluence and Lake Wildwood, in an effort to expand habitat range to the entire 4.25 mile stretch of creek, and up to 2.5 additional miles of Squirrel Creek, a tributary of Deer Creek below Lake Wildwood.

4. Collaborative Management of Lake Wildwood and Wastewater Treatment Plant: Lower Deer Creek's potential salmon and steelhead spawning habitat is gravely compromised by the presence of Lake Wildwood dam and wastewater treatment plant, with water temperatures in the fall that are lethal to fish, severe lack of suitable gravels, and an extreme excess of nutrients that contribute to rampant algae blooms. Restoration of viable habitat in this creek, the last tributary spawning grounds for the Yuba River before fish passage is blocked by Englebright Dam, depends on Lake Wildwood's and the Wastewater Treatment Plant's adoption of management practices that reduce impacts to the downstream ecosystem. Necessary changes include increasing the summer flow in order to reduce downstream temperature; releasing from cooler deep waters; collecting gravel during dredge operations for downstream placement; reducing the high flows during the periodic release by further lengthening the duration of the release; and reducing the input of nutrients from the Wastewater treatment plant. Central Valley Regional Water Quality Control Board is in the process of imposing stricter limits on nitrates and phosphates in effluent in order to meet their regional targets. Lake Wildwood has chosen Friends of Deer Creek to implement salmon habitat restoration improvements as a mitigation for their excessive nutrient loads, and that project will complement the current proposal. New technology exists that will result in reduced nutrient loads when implemented. Friends of Deer Creek has established a good working relationship with the Lake Wildwood Lake Committee over the course of several years, in the interest of preserving our shared environment. The fruits of this collaboration are already evident in changes that the Lake Committee has implemented in lengthening the duration of the periodic release, thereby reducing the high flows; posting signs that warn anglers of the dangers of mercury in fish; developing a joint water quality monitoring program at four sites in and below the reservoir; creating an inspection station for boats to prevent the spread of invasive non native species including quagga mussels; and collaborating in a study of mercury-laden sediment that is transported over the dam during storms. Friends of Deer Creek's board of directors includes John Norton, a Lake Wildwood resident, member of the Lake Committee, and retired program director at the California State Water Resources Control Board, who has been instrumental in establishing a partnership.

III. Species Limiting Factors

In this section, describe the limiting factors for spring-run Chinook salmon and steelhead in your watershed. The last page of this questionnaire defines the limiting factors.

Limiting Factors	Description (from back page)	Rank
☒ **Channel Form**	Lake Wildwood Dam's construction in 1970 has resulted in drastic changes to the channel form below the dam in the critical salmon spawning reach. While the presence of the dam has not essentially changed the peak flow, the dam prevents the passage of gravels that modulate flow. The fact that there is flow capable of transporting and depositing gravel without a supply of gravel has resulted in the creek incising into its bedrock and alluvium below Lake Wildwood to the confluence. The availability of flow but not of gravel and cobbles has also had the effect of incising the creek at the falls and steepening the gradient, transforming the falls into an impassible obstacle and limiting salmon and steelhead habitat range to the quarter mile stretch between the falls and the confluence. A further	Critical

	consequence of the combination of high flow and gravel starvation is bed armoring, particularly in reaches from Lake Wildwood to Squirrel Creek. Bed armoring is a particular problem in alluvial reaches, resulting in a reduction in habitat diversity. Finally, there is a large amount of angular sediment below the dam due to local erosion caused by construction at Lake Wildwood. Source data: Friends of Deer Creek Geomorphic Assessment, based on protocols developed by Montgomery and Buffington 1997.	
☒ **Channel Unit Types**	The lack of sediment has contributed to a reduction in riffle frequency caused by changes to the substrate. The stretch of creek below Lake Wildwood to the confluence with Squirrel Creek is particularly impacted by infrequency of riffles. The reduction in riffle habitat has the potential to raise temperatures, lower dissolved oxygen concentrations, and reduce habitat suitability. The lack of sediment also causes the creek to incise into alluvial step pools, reducing turbulent flows and dissolved oxygen concentrations. The reduction in gravel has also led to the deepening of pools, making them less suitable for spawning because of the loss of oxygenated flow. Deep pools can reduce the hyporheic flows needed to buffer daily temperature swings. Deep pools also reduce dissolved oxygen concentrations and contribute to algae blooms. Finally, the dam blocks large woody debris which can provide side channel pool habitat and help with gravel retention, thereby creating riffles and increasing the suitability of pools for spawning. The lack of woody debris decreases the diversity of channel units. Source data: Friends of Deer Creek Geomorphic Assessment, based on protocols developed by Montgomery and Buffington 1997.	High
☒ **Substrate**	Lake Wildwood dam blocks gravel and cobbles which would provide habitat to lower Deer Creek. The reach between Lake Wildwood and Squirrel Creek is particularly impacted, with only localized sediment inputs. The composition of the streambed below Lake Wildwood has been fundamentally altered since the construction of the dam because the reduction of the sediment supply has led to bed armoring, and a large median substrate diameter unsuitable for spawning salmonids. Fine sediment however is able to pass downstream, leading to a disproportionate amount of fine substrate too small for spawning habitat. Localized gravel recruitment leads to uneroded, angular gravels. The entire system is starved of suitable gravel supply because of the presence of the dam. Source data: Wolman Pebble Counts done in conjunction with Geomorphic Assessment.	Critical
☒ **Structure**	The presence of two dams (Lake Wildwood and Scotts Flat) has interrupted the continuous system that would bring large woody debris from upland forests. The lack of woody debris affects the distribution and spacing of riffles, runs, and pools. Debris creates unique and diverse habitat types including side channel pools, lateral pools, mid channel pools, and riffles.Source data: Friends of Deer Creek Geomorphic Assessment, based on protocols developed by Montgomery and Buffington 1997; Physical Habitat Assessments conducted in 2007 and 2008 in accordance with SWAMP Stream Habitat Characterization Form; Desktop analysis	High

III. Species Limiting Factors

	using Google Earth to assess canopy cover.	
☒ **Flow**	Lake Wildwood has a severe impact on flow, with inadequate flow in the summer months and unseasonal high flows during the annual dewatering. The dewatering event mimics a storm event, triggering salmon and steelhead to begin their upstream journey to spawn, where the eggs then dry up when the waters recede. The high flows also scour the vegetation and macroinvertbrates from the downstream section of the creek, causing severe impacts to riparian vegetation and habitat. The area is dominated by a single macroinvertebrate family, blackflies (Simulidae), and suffers from a critical lack of the macroinvertebrate diversity needed by salmonids. The entire Deer Creek watershed functions as a water management system. The natural flow regime would allow snowmelt to pass all the way into lower Deer Creek. Snow melt is now blocked and diverted at numerous places. Winter high flows are similar to historic highs, but data collected since 1934 reveals a significant reduction in summer flows resulting from Lake Wildwood's flow management (USGS). Below Lake Wildwood, less flow results in more pronounced diurnal temperature swing, and more severe environmental stresses on organisms. Source data: Flow regime analysis using USGS gauge data and Army Corps of Engineers Hydrologic Engineering Center Statistical Software Package.	Critical
☒ **Temperature**	Temperature is an urgent limiting factor in Lower Deer Creek. Temperature increases caused by human actions are a severe problem in lower Deer Creek. Temperatures of 24 degs C are lethal to salmonids, with 23 degs C being the LT50 (Baker). Ten years of temperature data on Deer Creek in the salmonid spawning reach reveal lethally high temperatures in the summer and fall spawning season, with peaks of 30 degs C (Friends of Deer Creek). Management activities on private land such as grazing, logging, gravel mining, and agriculture have led to degradation of the riparian corridor, reduction in riparian habitat and invasion by non-native plant species that bring reduced shade and habitat benefits. The lack of gravel and cobble in the streambed has led to a deepening of pools and a reduction in turbulent riffle flow and riffle spacing, all of which factors can lead to temperature increases (Grant et al, 2006). Managed flow from Lake Wildwood has significant impacts on downstream temperature caused by several factors: summer release of warm water from surface waters of the reservoir; extremely low outflows in summer in order to conserve reservoir depth; and a lack of natural variation in both flow and temperature, reducing the potential for hyporheic exchange to act as a temperature buffer (Poole & Berman). Source data: Friends of Deer Creek monthly water quality data; Onset HOBO data logger data during Lake Wildwood dewatering.	Critical
☒ **Water Quality**	The primary impacts to the water quality are nutrient loads, algae, and large diurnal swings in pH and temperatures.The wastewater treatment plant at Lake Wildwood releases significant quantities of nutrients into lower Deer Creek, which have contributed to excessive algae blooms. Algae take in oxygen and release carbon	Critical

	dioxide, leading to large diurnal swings in pH and dissolved oxygen, with severe impacts on stream organisms. Deer Creek below Lake Wildwood is 303(d) listed for pH as a result of excessive nutrient loads (http://www.waterboards.ca.gov). The impact of nutrient-laden effluent from the wastewater treatment plant is especially pronounced in summer when the low flows prevent effluent dilution. The lack of riparian canopy also increases the availability of solar radiation to the streambed, contributing to algae blooms. Denuded riparian areas do not uptake nutrients, leaving the nutrients available for algae growth. Source data: Friends of Deer Creek monthly monitoring data.	
☒ **Passage**	Fish passage is completely blocked by a waterfall located a quarter mile above the confluence with the Yuba River. Salmon and steelhead were historically able to scale these falls, but the lack of gravel, cobbles and large woody debris to act as natural fish ladders, has caused the creek to become deeply incised and the falls to become too steep to pass. Source data: Visual and Geomorphic Assessment based on protocols developed by Montgomery and Buffington 1997.	Critical
☒ **Riparian/Floodplain**	The riparian vegetation is significantly compromised both by the spread of invasive non-natives, and by private land management including grazing, logging, mining, and residential development, that has caused the banks to become denuded in places. Aerial photography reveals severely degraded vegetation in more than half of Deer Creek's riparian zone between Lake Wildwood and the Yuba confluence, and even more of Squirrel Creek's riparian zone in 3.2 miles above the confluence with Deer Creek.These impacts result in temperature increases, a reduction in nutrient uptake capacity, and the loss of fish and macroinvertebrate habitat. Riparian vegetation has been found by many studies to be critical in regulating stream temperature (Johnson & Jones, 2000). Riparian areas with higher plant density and basal area have temperatures up to 11% lower than areas with significantly lower plant density and basal area (Opperman & Merenlender, 2004). Non natives such as blackberry outcompete native species such as willow, alder, and cottonwood that provide suitable habitat including canopy, shading, root mats and root wads. The composition of the riparian vegetation zone is crucial to stream temperature regulation, and must include tree species that provide canopy (Broadmeadow & Nisbet, 2004). The riparian zone at the site is currently dominated primarily by shrub-like Himalayan blackberry and Scotch broom, which do not provide the necessary canopy cover to effectively regulate the stream temperature. Non natives such as scotch broom are more susceptible to wildfire, which in turn increases fine sediment load to the creek. Grazing animals cause further impact to native vegetation by spreading non-native seeds and by trampling and compacting soil, making it less hospitable to native species that require specific soil characteristics in order to be successful. The lack of large native riparian trees reduces the availability of large woody debris in the creek necessary for habitat and for fish passage. The lack of gravel has caused the creek to become incised, particularly in the alluvial reaches, and unable to access its	Critical

III. Species Limiting Factors

floodplain. Source data:Physical Habitat Assessments conducted in 2007 and 2008 per SWAMP Stream Habitat Characterization Form; Habitat Assessment conducted in conjunction with Friends of Deer Creek twice yearly Macroinvertebrate Bioassessment since 2000; streamwalk visual assessment, May 2008.

Source Documents:

Baker, P.F., Speed, T.P., and F.K. Ligon. 1995. Estimating the influence of temperature on the survival of chinook salmon smolts (Oncorhynchus tshawytscha) migrating through the Sacramento - San Joaquin River Delta of California. Can. J. Fish. Aquatic. Sci 52:855-863.

Broadmeadow, S. & Nisbet, T.R. 2004. The effects of riparian forest management on the freshwater environment: a literature review of best management practice. Hydrology and Earth System Sciences 8(3), 286–305.

California Water Resources Control Board
http://www.waterboards.ca.gov/tmdl/docs/303dlists2006/approved/BAK_Aug13thruOct30/state_06_303dlist.pdf

Friends of Deer Creek. www.friendsofdeercreek.org/data.html

Grant, Gordon et al. Potential effects of gravel augmentation on temperature in the Clackamas River, Oregon. A report prepared for Portland General Electric. 1 June, 2006

Johnson, S.L. & Jones, J.A. 2000. Stream temperature responses to forest harvest and debris flows in western Cascades, Oregon. Canadian Journal of Fisheries and Aquatic Sciences 57, 30–39.

Opperman, J.J. & Merenlender, A.M. 2004. The effectiveness of riparian restoration for improving instream fish habitat in four hardwood-dominated California streams. North American Journal of Fisheries Management 24, 822–834.

Poole, Geoffrey C. and Cara H. Berman. An Ecological Perspective on In-Stream Temperature: Natural Heat Dynamics and Mechanisms of Human-Caused Thermal Degradation. http://waterdata.usgs.gov/nwis/uv?11418500

Yoshiyama, R. M., E. R. Gerstung, F. W. Fisher, and P. B. Moyle. 2001. Historical and present distribution of chinook salmon in the Central Valley. Pages 71-176 in R. Brown, ed. Contributions to the biology of Central Valley salmonids. Fish Bulletin 179.
http://wfcb.ucdavis.edu/www/Faculty/Peter/petermoyle/publications/CentralValleyChinook.pdf

Additional Notes:

IV. Project Objectives—Environmental

In this section, describe how your project will affect <u>one or more</u> of the limiting factors for spring-run Chinook salmon or steelhead described above.

Limiting Factor	Description and Objective	Focus
☒ **Channel Form**	The gravel augmentation effort will affect the channel form by reducing the rate of channel incision into the streambed and bedrock. The armoring of the streambed that prevails in the reach between Lake Wildwood and Squirrel Creek will be mitigated by providing a	Primary

	more natural and diverse substrate regime, balancing out the large boulders and bedrock with smaller gravel, and reducing the incision rate. The project objective is to reduce the median substrate diameter by 25%.	
☒ **Channel Unit Types**	The project will place gravel in the sediment-starved reach of Deer Creek below Lake Wildwood, creating riffles and side pools that are necessary to decrease temperature and increase dissolved oxygen. Replacement of gravel will also prevent the creek from incising and developing deep stagnant pools. The revegetation project will provide sources of large woody debris that help to create diverse channel unit types. The project objective is to increase riffle habitat by 30%.	Primary
☒ **Substrate**	The addition of gravel recovered from Lake Wildwood and from Yuba River sources will reduce the median substrate diameter to a diameter more suitable for salmon spawning. Diverse substrate will reduce incision and create more spawning bed habitat. The presence of large quantities of angular sediment from local sources will be mitigated by a combination of removal of angular gravel where practical and increased abundance of rounded pebbles more suitable for spawning habitat. Finally, the addition of diverse substrate will create more hyporheic flow by creating riffles and raising the bed elevation, resulting in reduced temperature and increased dissolved oxygen levels. The project objective is to reduce median substrate diameter by 25%.	Primary
☒ **Structure**	The proposed revegetation effort in the riparian zone below Lake Wildwood and along Squirrel Creek will replace low-lying invasive shrubs with native trees, resulting in local sources of large woody debris. Woody debris facilitates the creation of riffles and pools, and acts as a natural fish ladder. The project objective is to increase woody debris biomass by 100%.	Primary
☒ **Flow**	The gravel augmentation will affect the flow regime by raising the bed elevation, decreasing surface flow and increasing subsurface hyporheic flow. The revegetation will affect flow by providing a source of large woody debris which will create diverse channel unit types and an increase in riffles and sidepools. We will negotiate with Lake Wildwood and Nevada Irrigation District (NID) to make changes to their future management strategies that may include releasing colder water, reducing flow during the periodic dewatering by lengthening the timeframe, and ensuring that the summer release meets the minimum flow levels required under the terms of their permit. The project objective is to ensure that Lake Wildwood's spring, summer and fall flows meet their permitted requirements 100% of the time.	Primary
☒ **Temperature**	The project will realize significant improvements to temperature. We plan to import gravel recovered from Lake Wildwood and from the Yuba River, to create riffles that have the capacity to reduce temperature and increase dissolved oxygen. We will work with Lake Wildwood to manage the summer release of water from a lower depth, so that colder water is entering the stream. We will work with landowners to fence grazing animals out of the riparian zone so that	Primary

IV. Project Objectives—Environmental

	native vegetation can become established, and will focus revegetation efforts on increasing the supply of native shade trees. The project objective is to reduce instances of lethal temperature peaks to zero.	
☒ **Water Quality**	Water quality impacts are interconnected, with the lack of riparian vegetation and canopy contributing to high temperatures and the growth of excessive algae blooms, which in turn leads to large diurnal swings in pH and temperature. The proposed revegetation will increase canopy and overall biomass, thereby increasing the capacity to uptake the nutrients that feed algae blooms and reducing temperature and solar radiation, further reducing algae blooms. The reduction of algae blooms in turn will reduce pH and dissolved oxygen concentration swings. The gravel augmentation will raise bed elevation and create riffle habitat, with increased turbulence that increases dissolved oxygen concentrations. The gravel will also increase subsurface flow to provide a buffer against temperature spikes. We will reduce algal biomass by 25%, and nutrients by 25%.	Primary
☒ **Passage**	The project will include an effort to restore passibility to the falls a quarter mile from the Yuba confluence in order to regain four miles of salmon habitat on Deer Creek and up to 2.5 miles on Squirrel Creek. It is hypothesized that the falls have become excessively steep for a combination of human-caused reasons, including the lack of gravel that causes the creek to incise, and the geomorphological changes to the creek that were caused by intensive gold mining in the creek beginning in the Gold Rush. We plan to restore passibility by a combination of gravel augmentation to raise the streambed height and fall height reduction, by removing accumulated debris at the top of the falls. The project objective is to increase habitat range by 4 miles on Deer Creek and 2.5 miles on Squirrel Creek.	Primary
☒ **Riparian/Floodplain**	The project includes an extensive revegetation effort along 4.25 miles of Deer Creek and an additional 3.2 miles of Squirrel Creek. The denuded areas will be replanted with native trees; invasive non-natives will be removed and replaced with native vegetation; and grazing animals that compact the soil and eat the seedlings will be fenced away from the riparian zone. The gravel augmentation effort will prevent the creek from incising and will allow it to access its floodplain. Friends of Deer Creek's wide volunteer network and relationships with private landowners make us uniquely positioned to implement revegetation efforts on private land and to work with landowners to make beneficial changes to private land management practices. We will reduce the total denuded area of the riparian zone from 33% to 15%.	Primary

V. Project Objectives—Biological

In this section, describe the objective(s) of your project relative to the goal of providing habitat for spring-run Chinook salmon and steelhead. Indicate the species and life stage that are targeted by the project. (It is okay to have more than one species/life stage target).

Target Species: ☒ Spring-Run Chinook Salmon **Population Status Specific to Watershed:** Intermittent

Target Life Stages:

☒ Spawning ☒ Egg Incubation ☒ Summer Rearing ☒ Winter Rearing

☐ Juvenile Emigration ☒ Adult Immigration ☐ Adult Holding

Description of Project Objectives:

The objective of the project is to increase the proportion of Yuba River salmon found on Deer Creek by 5-10%. The habitat requirements for spring-run Chinook salmon will be addressed in the following manner by the proposed project:

Adult Immigration: High temperatures deter adult salmon from entering their natal streams, and are a problem in Deer Creek for the reasons stated in III above. Our monthly monitoring data, available on our website, indicates that the temperature range in the creek is just above the upper limit of tolerable temperature range. High temperature peaks and extreme temperature swings will be addressed by revegetating to increase shade; by adding gravel to increase riffle habitat and hyporheic flows; and by working with Lake Wildwood management to release water in summer from lower and colder depths of the reservoir. Migrating salmon avoid streams with excessive turbidity. Deer Creek's turbidity is not excessive, but the revegetation project will address sediment loads by vegetating denuded banks to reduce erosion. We will also work with landowners to fence grazing animals away from the riparian zone, where they contribute to erosion by compacting the soil and eating seedlings. In order to expand the available habitat on Deer Creek beyond the current 1/4 mile, it is necessary to address the impassibility of Basher Falls and determine whether it can be made passible. A survey of the falls will examine pool depth to falls height ratio, vertical and horizontal distance, and whether an alternate route under the falls can be developed to facilitate fish passage.

Spawning: The most significant variables affecting spawning habitat are substrate composition, cover, water quality and water quantity. In terms of water quantity, flow is impacted in Deer Creek by Lake Wildwood dam, with low summer flows and unnaturally high flows during the periodic dewatering. Suitable salmon spawning habitat requires sufficient but not excessive flow, and our work with Lake Wildwood will focus on ensuring that minimum summer flows are observed and that the duration of the dewatering is extended to allow a lower flow rate. Temperature provides an important cue for spawning salmon, with the ideal temperature range being 5.6-13.9 deg C. Timing of spawning must take into account the seasonal temperatures that affect subsequent incubation success rates - successful spawning requires suitable temperatures at just the right time. As outlined above in Adult Immigration, temperature impacts will be addressed by a combination of revegetation efforts, reservoir management strategies, and gravel augmentation. Of critical importance to spawning habitat is suitably-sized substrate, with salmon requiring gravel in the range of 1.3 to 10.2 cm. Up to 80% of the gravel should be in the range of 1.3 to 3.8 cm, with the remainder up to 10.2cm. As outlined above, the targeted stretch of creek is gravel-starved as a result of the dam at Lake Wildwood that prevents the passage of gravel downstream. The gravel augmentation effort in this project will recover gravel from the reservoir and augment with purchased gravel from a Yuba River source in order to increase the ratio of suitable substrate. Finally, spawning salmon require adequate cover for shade and for protection from predators. Cover may be provided by overhanging vegetation, undercut banks, submerged vegetation, submerged objects such as logs and rocks, floating debris, deep water, turbulence, and turbidity. The project will include an extensive revegetation of the riparian zone focused on increasing native shade cover and providing a supply of large woody debris.

Incubation: While spawning habitat is also incubation habitat, the needs of embryos during incubation differ from those of adults. Of particular importance is the quantity of fine sediment that can block oxygenated flow in the redds and restrict alevin movement. The revegetation will reduce fine sediment loads by restoring erosion-prone denuded

V. Project Objectives—Biological

areas. Dissolved oxygen concentrations also have an impact on incubating salmon, with low and medium DO levels corresponding to smaller, weaker and fewer alevins. DO concentrations are impacted by temperature, surface and intragravel water interchange, substrate permeability, and oxygen demand of organic material in the redd. The project will result in increases in dissolved oxygen levels by reducing water temperature through a combination of revegetation, gravel augmentation, and changes to reservoir management; reducing algae blooms by increasing riparian vegetation that will uptake nutrients and provide shade; increasing the proportion of gravels to fine sediment; and increasing riffle habitat and thereby increasing hyporheic flow. Incubation success is influenced strongly by temperature, with temperatures in the higher end of the ideal range greatly reducing the number of days until embryos hatch. Proposed temperature mitigations are as described under "Adult Immigration", above.

Rearing: Abundance of juvenile salmon is impacted by a range of variables including vegetative cover, protection from predators, abundance of food sources, flow, water quality including DO concentrations and pH, temperature, competition, depth, velocity, and substrate. Project impacts to temperature, water quality, flow, substrate, and vegetative cover/protection from predators have been discussed in the above sections. The project will have a significant impact on macroinvertebrate habitat, with habitat improvements resulting from the revegetation and substrate improvements. Macroinvertebrates constitute the major food source for salmonids. Both suitably-sized substrate and large native trees and their woody debris are crucial in increasing macrinvertebrate populations and in providing protective cover to juvenile salmon.

Target Species: ☒ Steelhead

Population Status Specific to Watershed: Extirpated

Target Life Stages:

☒ Spawning ☒ Egg Incubation ☒ Summer Rearing ☒ Winter Rearing

☐ Juvenile Emigration ☒ Adult Immigration

Description of Project Objectives:

The project objective is to return steelhead to Deer Creek. While steelhead were historically present in the watershed, it is thought they are no longer found here. The project impacts for spring-run chinook habitat will yield comparable benefits for steelhead. The temperature range for spawning steelhead is 3.9-9.4 deg C. There is considerable overlap in the ideal range for all habitat variables for salmon and steelhead, and the project will yield benefits that will accrue to both species. While steelhead are not currently present in Deer Creek because of habitat degradation, they are still present in the Yuba River in the vicinity of Deer Creek, and it is hoped that the project will restore Deer Creek's habitat to viability.

VI. Project Cost

Capital Cost: $75,000 for equipment

Annual Operation and Maintenance Cost: $174,000 annual operation costs for the project term of 3.25 years

$275,000 annual maintenance costs

Annual Operation and Maintenance Description: For the 3.25 year term of the project, the project will salvage gravel from Lake Wildwood and purchase additional Yuba River gravel as needed; deposit the gravel below Lake Wildwood dam and at the falls annually; remove non-native riparian vegetation; revegetate with native vegetation; irrigate as needed; monitor and remove non-native vegetation; conduct meetings with Lake Wildwood Lake Committee to implement management changes; survey barriers to fish passage and remediate; implement monitoring program.

VI. Project Cost

Project Lifespan:	Funding is requested for the 3.25 year project term. Operating and maintenance activities are expected to be required indefinitely, as long as the dam at Lake Wildwood is present. Immediate benefits are expected in macroinvertebrate populations, as soon as suitable gravel is restored, with salmon and steelhead numbers showing an improvement within three years. Long term benefits in riparian vegetation will continue to accrue for the next ten years.
Project Partners (Funding):	Nevada County Sanitation District #1, a compensatory mitigation imposed by California Department of Fish and Game.
Project Partners (Maintenance):	Lake Wildwood Association will be maintenance project partners, providing salvaged gravel and other remedial actions in their management plan as developed in the scope of the project.

VII. Schedule

Proposed Start:	September 2009
Expected Time to Completion:	December 2012
Expected Time to Realize Environmental Benefits:	2019
Expected Time to Realize Biological Benefits:	December 2012

VIII. Feasibility

Technical Feasibility:

The technical elements of the project include gravel augmentation, riparian revegetation, and barrier removal.

The gravel augmentation element is feasible because we have convenient access for depositing gravel loads at Lake Wildwood dam, as well as a cooperative relationship with Lake Wildwood Lake Association who have granted us permission to access their land for this purpose. Lake Wildwood Association has been seeking solutions to the issue of gravel starvation in the lower reach, and is strongly supportive of efforts to recover gravel from the lake and place it below the dam. If the recovered gravel proves to be unsuitable or insufficient, we have identified an alternative source of gravel from the Yuba River, which can be trucked in to the site.

The riparian revegetation effort is feasible because of our strong relationships developed over many years with landowners along the creek, some of whom are volunteers and monitors for our organization. We have secured formal consent to implement revegetation efforts from landowners of approximately one third of the land area along Deer Creek between Lake Wildwood and the Yuba confluence, and will continue working to secure additional permissions. Friends of Deer Creek has already completed a similar revegetation effort that involves the removal of non-natives and replacement with native trees and plants in an upstream reach, and has developed a method of incremental removal of

VIII. Feasibility

invasives to avoid exacerbating the erosion problem; revegetation in targeted sections that can outcompete the invasive vegetation; and gathering of native seedlings and cuttings from a variety of specimens in the project area in order to ensure genetic diversity and suitability.

Barrier removal will consist primarily of a feasibility study to determine the best method of bypassing Basher Falls and implementation as appropriate. The effort to restore passibility by targeting gravel placement to elevate streambed height is made possible by good access at the falls, that will allow us to focus a specific "gardening"-style gravel placement at the site. The introduction of large numbers of native trees will restore the supply of large woody debris that in the past acted as a natural fishladder to facilitate fish passage.

Technical Challenges:

Technical challenges remain in the restoration of passibility to the falls. Anecdotal evidence suggests that historically, salmon and steelhead were able to scale these falls and were found in the upper reaches of Deer Creek, but the falls are known to have been impassible since at least the 1920's, before the construction of Lake Wildwood dam. An initial study of the falls has shown that there is an access point at the bottom of the falls approximately 10" in diameter, and that it is possible that fish passage could be occur via this route instead of up the face of the falls. If fish passage cannot be restored, the habitat range will be limited to the first quarter mile of stream above the Yuba confluence, but riparian revegetation and gravel augmentation efforts would be implemented in the entire 4.25 mile stretch of the creek between Lake Wildwood and the confluence in order to realize greater temperature and pH improvements.

The temperature peaks in the creek currently are lethal to spawning fish, and a primary goal of all elements of the project is to reduce temperature peaks and swings. The related projects below reveal that improvements in temperature suitability result from each planned remediation strategy, and taken together we believe that the project in its entirety will restore habitability.

Related Projects:

All elements of the project have been successfully implemented in other waterways:

Barrier Removal: In Puget Sound, when access to 145 rkm in the upper Skykomish River above Sunset Falls (a natural barrier) was provided, chinook and pink salmon penetrated the upper reaches of the basin, and their populations peaked in 15 and 25 years, respectively (Seiler 1991).

Nutrient Uptake: The plan to plant native plants in denuded areas and as a replacement for non-native shrubs has been shown to result in a significant reduction in nutrient loads in the creek, with willows being extremely efficient at nutrient uptake (Byrd & Kelly 2006).

Native Revegetion Benefits: A revegetation project in Mendocino County targeted at steelhead habitat restoration yielded significant temperature benefits, beneficial changes in channel morphology, and a supply of large woody debris within 10-20 years that was equal to that found on similar streams in mature forest (Opperman & Merenlender 2004).

Gravel Augmentation: East Bay Municipal Utility District has implemented a series of gravel augmentation activities over several years in the Mokelumne River just below Comanche Dam. The augmentation has yielded multiple

VIII. Feasibility

	benefits, including the immediate return of spawning Chinook salmon to two sites; a 12% increase in the quantity of suitably-sized gravels; increased dissolved oxygen and decreased temperatures; and macroinvertebrate populations in the new gravel that are equal to those found in established gravel (Bjornn & Reiser, Mokelumne).
Ownership or Permitting Challenges:	We are fortunate to have developed harmonious relationships with several landowners along the creek and with Lake Wildwood. Therefore, it is not anticipated that land ownership issues will be a significant obstacle. We have applied for the following permits for this project: Army Corps of Engineers, Section 404 Permit Department of Fish and Game, Lake and Streambed Alteration Permit Central Valley Regional Water Quality Control Board, Water Quality Certification Section 401 Permit
Conflicts with Cultural, Zoning, or Other Issues:	There are no known conflicts with cultural, zoning, or other issues. On the contrary, our close collaboration with the Tsi-Akim Maidu has revealed to us that the return of the salmon people to their ancestral lands is their highest priority, as indicated by their revival of the "Calling Back the Salmon" ceremony for the past few years in the fall. Efforts to restore salmon habitat are of paramount cultural importance.

IX. Project Support

Supporting Entities:	The Tsi-Akim Maidu Tribe is supportive of the goals of this project. Support for elements of this project is implicit in the fact that in August 2008 the California Department of Fish and Game included Deer Creek on its list of 22 priority streams for future instream work. The list was compiled and ranked based on input from Regional DFG staff, staff from the State Water Board, U.S. Fish and Wildlife Service, and the National Marine Fisheries Service, using the following criteria: 1) Presence of anadromous species; 2) likelihood that DFG flow recommendations would provide a high level of improvement; 3) availability of recent flow studies or other relevant data; and 4) the possibility of partners/willing landowners. T
Cooperating Entities:	Lake Wildwood, Nevada County Sanitation District #1, and private property owners along the affected stretch of creek have all offered their formal cooperation, and support letters are available.
Degree of Local Support:	Friends of Deer Creek enjoys a high degree of local support and places a priority on building cooperative relationships with all affected parties, private and public. Several homeowners along the creek have become volunteers and monitors; the city of Nevada City is currently partnering with us on an EPA-funded Brownfield Assessment of abandoned mines on city-owned land, and has provided us with low-rent office and lab space for the past decade; Lake Wildwood has collaborated with us on mulitple projects and, as a result of our collaboration, has modifed its management practices of the reservoir to take into account impacts to the creek; and we are developing an eight mile community trail along the creek, in partnership with several local groups, which promises to

IX. Project Support

	be a highly valued local resource and which has engendered much support and volunteer hours from a broad spectrum of the community. These relationships make it possible for us to accomplish many things that would be hard for a state agency to do, especially when access to private property is required as it is in this project.
Known Opposition:	There is no known opposition to this project.

X. Supporting Documents

Please provide a full reference for each citation used to support the information presented in this questionnaire.

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http://wfcb.ucdavis.edu/www/Faculty/Peter/petermoyle/publications/CentralValleyChinook.pdf

X. Supporting Documents

Definitions of Limiting Factors for Spring-Run Chinook Salmon and Steelhead

Channel Form

This attribute describes changes to the channel, including incision, aggradation, diking, armoring, and other modifications of the channel adversely affecting spring-run Chinook salmon and steelhead.

Channel Unit Types

Examples of geomorphic features of the channel that form habitat types for spring-run Chinook salmon and steelhead are pools, riffles, glides, and runs. This attribute describes changes in the frequency and size of such features. For example, removal of large wood may reduce the frequency of pools, presence of steps, or retention of gravel for riffles.

Substrate

This attribute describes changes in the composition of the substrate of the stream, including increase in fine sediment and lack of gravel recruitment.

Structure

This attribute describes the loss of structural elements in the stream such as large wood, boulders, undercut banks, and so on. Loss of structure results in a simplification of the channel and influences Channel Form and Channel Unit Types.

Flow

This attribute addresses modification of the flow regime, including decrease in summer low flow, increased "flashiness," and dewatering of the channel as a result of withdrawals.

Temperature

Change in water temperature can be attributable to human actions such as removal of riparian shading. This attribute describes the increase in summer water temperature and the loss of temperature refugia (springs or groundwater) as a result of human actions.

Water Quality

This attribute pertains to the input to the stream of toxins or pollutants that produce adverse impacts on spring-run Chinook salmon or steelhead. This can include chemical pollutants such as fertilizer and pesticides and nutrient sources such as cattle and feedlots.

Passage

This relates to the effect of impediments to adult or juvenile migration of spring-run Chinook salmon or steelhead, including dams, culverts, channel dewatering, and other structural and channel modifications. Please describe the location of the passage impediment and describe the extent of impediment (i.e., a complete or partial blockage to migration).

Riparian/Floodplain

This attribute describes the loss of functionality of the riparian forest/vegetation and the connection of the stream to the floodplain during high water and flooding.

Population Condition Definitions for Section V. Project Objectives—Biological

Increasing

Adult returns of the target species to the watershed have generally been increasing over the last several years; expectations are that the species is displaying characteristics of a rebuilding or healthy population.

Stable

Adult returns of the target species to the watershed show no clear trend over the last several years.

Decreasing

Adult returns of the target species to the watershed are declining over the last several years; the decline in abundance is a cause of concern and characteristic of a potentially unhealthy population.

Intermittent

Adult returns of the target species are occasionally seen in the watershed, but there is no viable or sustained population in the basin.

Extirpated

The population has been eliminated from the watershed although the species was present in the past.

Never Present

The species has never been known to occur in the watershed.